Current State of Diesel Technology and Future Advancements

prepared for the

STATE OF NEW JERSEY
CLEAN AIR COUNCIL

January 8, 2019
Allen Schaeffer

Executive Director, Diesel Technology Forum
Meet the Leaders

In Clean Diesel Technologies
1. Overview of Diesel in New Jersey: commercial vehicles, new technology diesel engines, fuels, etc.
2. Update on the current state of diesel technology in on- and off-road applications
3. What is the current state of biofuels?
4. What is the penetration of new technology diesel engines in the U.S. and New Jersey trucking fleet?
5. What is expected in the near term for further criteria pollutant and GHG emission reductions?
6. Recent research into large engines and the benefits they provide near-port community
7. Q&A
8. Resources Available
One Out of Every Two Economic Sectors Relies on Heavy-Duty Vehicles, Equipment or Engines to Get the Job Done
Diesel Power in New Jersey

Positive Train Control cable installation on the Atlantic City Rail Line.

The first phase of work to replace wood catenary poles on the Gladstone Branch was completed in FY2018.

This mobile diesel generator can help provide backup power during major power outages.

NJ TRANSIT ordered 65 new articulated buses in FY2018 for use on high-ridership routes.

NJTRANSIT  The Way To Go.

Diesel’s many roles in NJ

Infrastructure, Emergency Response, Resilience, Climate Plans

WHAT’S NEW?
Governor Phil Murphy Signs Executive Order 28 directing all New Jersey State Agencies with responsibilities under the Offshore Wind Economic Development Act (OWEDA) to fully implement OWEDA in order to meet a goal of obtaining 3,500 MW from offshore wind by the year 2030.

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EMERGENCY STANDBY GENERATOR, LOCATION LISTING – NJSPP CENTRAL AND SOUTHERN REGIONS (T2:299)

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>ADDRESS</th>
<th>COUNTY</th>
<th>REGION</th>
<th>MAKE</th>
<th>FUEL</th>
<th>KW TANK (gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bordentown Tower</td>
<td>Rt 130, N. Bordentown, NJ 08505</td>
<td>Burlington</td>
<td>Central</td>
<td>Onan</td>
<td>Diesel</td>
<td>90 1000</td>
</tr>
<tr>
<td>Princeton Tower</td>
<td>166 Rose Road, Princeton, NJ 08540</td>
<td>Burlington</td>
<td>Central</td>
<td>Onan</td>
<td>Diesel</td>
<td>90 200</td>
</tr>
<tr>
<td>Princeton, Towar</td>
<td>3925 US Hwy 1, Princeton, NJ 08540</td>
<td>Middlesex</td>
<td>Central</td>
<td>Onan</td>
<td>Diesel</td>
<td>50 1000</td>
</tr>
<tr>
<td>Allentown</td>
<td>2301 Allentown Avenue, Wall NJ 07719</td>
<td>Monmouth</td>
<td>Central</td>
<td>Onan</td>
<td>Diesel</td>
<td>30 200</td>
</tr>
<tr>
<td>Sea Girt Lab.</td>
<td>Sea Girt Ave, Sea Girt, NJ</td>
<td>Monmouth</td>
<td>Central</td>
<td>Onan</td>
<td>Diesel</td>
<td>15 NA</td>
</tr>
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Diesel's many roles in NJ

Infrastructure, Emergency Response, Resilience, Climate Plans

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NJ State Profile

https://www.dieselforum.org/new-jersey
Diesel is a Platform of Continuous Improvement

First Generation  Current Generation  Next Generation
Continual Progress of Diesel Technology Delivers Benefits

PROGRESS TO NEAR-ZERO PM & NOx EMISSIONS

EPA Tailpipe Emissions Standards for Heavy-Duty On- and Off-road Applications
What Is New Technology Diesel?

Diesel Emissions Control System

- Exhaust gases leave engine
- Particulates (PM) trapped in diesel particulate filter
- DEF injected into exhaust
- Reduced volume of emissions leaves tailpipe, PM and NOx near zero levels.
- NOx reduction in SCB Catalyst

This schematic shows how Selective Catalytic Reduction (SCR) with a Diesel Particulate Filter (DPF) System works. Untreated exhaust gas passes from the engine into a DPF that traps over 95 percent of particulate matter or soot. The exhaust moves into a catalytic chamber where the exhaust gas is dosed with a precise spray of diesel exhaust fluid (DEF) reacts with oxides of nitrogen (NOx) on a special catalyst and converts these gases into nitrogen dioxide and water vapor. The system reduces PM and NOx and other emissions to near zero levels.

* *Schematic is not representative of all manufacturers’ approach to achieve near-zero emissions.*
Diesel is the Technology of Choice for America’s Trucks

75% of all commercial vehicles in the U.S. are diesel-powered.

43% powered by newest generation of advanced diesel technology.

6.8% increase since last year.

Source – July 2019 U.S. Vehicles in Operation Data (Class 3-8 vehicles, Model Year 2010 and newer) provided by IHS Markit.
Growth of New Technology Diesel Trucks on the Road Class 8, classes 3-8

97% of Class 8 big rig trucks are diesel-powered

44% powered by newest generation of advanced diesel technology

7.3% increase since last year

Source: July 2019 U.S. Vehicles in Operation Data (Class 3-8 vehicles, Model Year 2010 and newer) provided by IHS Markit
**Midwest Leads in Adoption of New Technology Diesel Trucks**

**Percentage of Newest Generation Heavy-Duty Trucks**

**Ranking**

1. Indiana 65%
2. Oklahoma 56%
3. Utah 55%
4. Texas 50%
5. Pennsylvania 48%
6. Tennessee 47%
7. Maryland 47%
8. Illinois 46%
9. D.C. 46%
10. Wyoming 45%

**Source** – July 2019 U.S. Vehicles in Operation Data (Class 3-8 vehicles, Model Year 2010 and newer) provided by IHS Markit

**Percentage of Newest Generation Heavy-Duty Trucks by U.S. EPA Region**

**Source** – July 2019 U.S. Vehicles in Operation Data (Class 3-8 vehicles, Model Year 2010 and newer) provided by IHS Markit
New Jersey Ranks 21st nationwide for new technology diesel trucks on the road

Mid Atlantic Region

<table>
<thead>
<tr>
<th>Share of New Tech Diesel Trucks</th>
<th>State</th>
<th>National Average = 43%</th>
</tr>
</thead>
<tbody>
<tr>
<td>41.2%</td>
<td>New Jersey</td>
<td></td>
</tr>
<tr>
<td>45.5%</td>
<td>D.C.</td>
<td></td>
</tr>
<tr>
<td>39.4%</td>
<td>Delaware</td>
<td></td>
</tr>
<tr>
<td>35.1%</td>
<td>West Virginia</td>
<td></td>
</tr>
<tr>
<td>46.6%</td>
<td>Maryland</td>
<td></td>
</tr>
<tr>
<td>34.3%</td>
<td>Virginia</td>
<td></td>
</tr>
<tr>
<td>47.6%</td>
<td>Pennsylvania</td>
<td></td>
</tr>
<tr>
<td>38.6%</td>
<td>North Carolina</td>
<td></td>
</tr>
<tr>
<td>41.9%</td>
<td>Mid Atlantic Region</td>
<td></td>
</tr>
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Bottom States for Adoption of New Diesel Trucks

<table>
<thead>
<tr>
<th>State Ranking</th>
<th>Share of New Tech Diesel Trucks</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>#40</td>
<td>36.3%</td>
<td>CALIFORNIA</td>
</tr>
<tr>
<td>#47</td>
<td>32.3%</td>
<td>SOUTH DAKOTA</td>
</tr>
<tr>
<td>#48</td>
<td>32.0%</td>
<td>HAWAI</td>
</tr>
<tr>
<td>#49</td>
<td>31.8%</td>
<td>ARIZONA</td>
</tr>
<tr>
<td>#50</td>
<td>31.0%</td>
<td>ALASKA</td>
</tr>
<tr>
<td>#51</td>
<td>30.6%</td>
<td>KENTUCKY</td>
</tr>
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</table>
These new generation diesels are delivering significant clean air, and GHG benefits to society and fuel savings to truckers -- **TODAY.**

**New Technology Diesel Trucks Deliver Big Benefits for Climate and Clean Air**

- **Fewer Emissions**
  - $126M$ Tonnes of CO$_2$
  - $18M$ Tonnes of NOx

- **Saved Fuel**
  - $12.4B$ Gallons of Diesel Fuel
  - $296M$ Barrels of Crude Oil

*Source – July 2019 U.S. Vehicles in Operation Data (Class 3-8 vehicles, Model Year 2010 and newer) provided by IHS Markit*
• “In sum, the ACES results demonstrate the effectiveness of modern aftertreatment technologies used in the modern diesel engines: they greatly reduce the emissions of PM, NOx, and NO2, and the levels of other toxic components of NTDE, when tested in the laboratory using FTP and more stringent testing cycles.”

• “After a lifetime of exposure, NTDE does not produce tumors in rats, unlike TDE. Thus, the ACES results demonstrate the effectiveness of DPFs, not only in greatly diminishing the amount of PM from new-technology engines, but also in reducing the toxicity of NTDE significantly as compared with TDE.”

What’s up Next – Closer to Zero Emissions for Trucks

Cleaner Trucks Initiative:
EPA is Seeking Comments on the ANPRM for the Regulatory program for new HD truck Engines, on issues noted below

• Lowering the tailpipe standard below the “0.2” current standard
• Test Cycle to include idling and low-load operations representative of urban driving
• Expanding useful life of emissions controls beyond 435,000 miles. Evidence suggests real-world useful life of over 900,000 miles
• Expanding warranties on emissions controls beyond 100,000 miles. Most OEMs offer 250,000 mile warranties
• Inclusion of real world driving standards for in-use testing
• Consider tamper resistant electronic controls for emissions
• Incentives for zero-emissions technologies
Nationwide Benefits

Phase 1&2 Rules will be Implemented....and Diesel Will Continue to Deliver Significant Benefits.

Between 2011 and 2030, Diesel Class 3-8 Trucks Will Have Saved....

130 billion gallons of fuel
1.3B tonnes CO2 = Emissions from the electricity used in 227M homes for 1 year
73 Million tonnes of NOx = Emissions from all light-duty vehicles for 26 years
4 Million tonnes of PM = Emissions from all light-duty vehicles for 130 years
Anticipated Benefits to the Northeast

What are the benefits that more efficient commercial vehicles will bring to the region between 2010 and 2030?

- 12.9 billion gallons of fuel saved
- 307 million barrels of crude oil
- 131 million tonnes CO₂

Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont
How Will We Get There?

Hybridization
Electrification
Waste Heat Recovery
Engine Downs speeding
Engine Downsizing
High Pressure Direct Injection CNG
Predictive Cruise Control
Low Rolling Resistance Tires
Aerodynamic Designs
Light Weight Components
Advanced Transmissions
Many More.....
“Hybrid diesels and CNG account for most of the lost market share.”
Diesel Technology will continue to dominate HD Truck Sector beyond 2040

“Advancements in the diesel engine allow it to remain cost competitive to new technologies to 2040, but share will decrease over time.”
Diesel’s combined core attributes are formidable: Power density, performance, reliability, durability, maintainability, scalability, most energy efficient internal combustion engine, economical ownership and operation, near-zero emissions, able to utilize renewable biofuels, nationwide-accessible fuel, servicing, parts networks, known secondary sales markets, flexibility in routing.

Truck and Engine Manufacturers are exploring a range of alternatives including all electric, hydrogen.

Greatest suitability for alternatives to diesel likely to come in regular routes, short range, urban operation, refueling/charging issues solvable and affordable.
What if Diesel Engines didn’t run on diesel fuel?

**Advanced Biofuels**
- At least 50% reduction in GHG emissions

**Biodiesel**
- Feedstocks:
  - Waste Animal Fats
  - Waste Vegetable Oils
- Blends Up to 20%
- No additional fueling infrastructure needs

**Renewable Diesel Fuel**
- Feedstocks:
  - Waste Animal Fats
  - Waste Vegetable Oils
- 100% Replacement to Petroleum Diesel Fuel – meets the same technical specs as petroleum diesel
- No additional fueling infrastructure needs

Use of Low-carbon renewable biofuels in existing diesel engines both new and existing can occur overnight with little to no changes in operations.

80% to 86% Reduction in GHG emission
Big Benefits from Advanced Biofuels

Of all the fuel types and technologies, biodiesel and renewable diesel are contributing the greatest CO2 reductions in California. It takes a diesel engine to realize the benefits.

C02 Reduced (2011-2018)
Renewable Diesel and Biodiesel = 18.9 million tons
Ethanol = 18.8 million tons
Battery-Electric = 2.5 million tons
Biodiesel & Renewable Diesel Fuel Are Coming out East

Neste and the Port Authority of New York & New Jersey (PANYNJ), have signed a Memorandum of Understanding on a joint sustainable fuel initiative.

The partners will be working together to facilitate the use of sustainable transportation fuels at Port Authority facilities and in its fleet vehicles and equipment, including renewable aviation fuel, renewable diesel, renewable propane and other sustainable fuel products.
## Timelines

<table>
<thead>
<tr>
<th>Vehicle and Equipment Sectors</th>
<th>Technology and Fuel Availability</th>
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| **Advanced renewable biofuels:** | **ALL (on road, off Road)**  
No hardware changes to vehicles required;  
*change fuel filters at outset regular maintenance* | **Available today;**  
Fueling infrastructure in place; Barge or road or rail tanker loads to users; |
| **New technology diesel engines** | **ALL – HDOH, (Since 2007 all have PM filters; Since 2011, all have PM Filters and SCR systems)**  
Off road engines and equipment 2014 and later MY – construction, generators, marine, etc. | **Available today.**  
Diesel Exhaust Fluid (DEF) for SCR systems widely available  
Available today |
| **Next step in Lower Emissions from new HDOH diesel trucks** | **Commercial trucks over 10,000 lbs gvwr**  
EPA Rule to further reduce NOx emissions | **ANPRM Jan 6, 2020;**  
**NPRM by COB 2020**  
Final rule expected early 2021; **likely** implementation 2025 (optional)-2027; |
| **Reductions in CO2 emissions, increase in fuel efficiency** | **Commercial trucks EPA NHTSA GHG Rules;** | **2014 Phase 1 rule implementation**  
**2021 Phase 2 rule Implementation** |
Final Thoughts

• New Technology Diesel engines are achieving near zero emissions today; new rulemaking for Heavy duty trucks ensures lower emissions for the future, and lower greenhouse gas emissions.

• Legacy product solutions – emissions control devices and repowers are available for some sectors and applications; DERA funding available and successful; balance costs and investment versus buying new technology. Industry and DTF strongly supports state anti-tampering and emissions inspection efforts, crackdown on coal-rolling.

• Use of advanced renewable biofuels across existing fleets brings fast carbon reduction benefits to large vehicle populations with minimal investments.

• Promise of alternatives to diesel not borne out; economically, technically or temporally at this time. Manage expectations, balance hype with commercial product availability.

• Attacking climate and clean air challenge will require many solutions; new generation of diesel technology is one of them.
Coming Next .... Recent Research on Ports and Emission Reduction Strategies

Marine engines are **2X as long lived** as EPA emissions models assume.

Marine engines are **among the most cost effective** projects to reduce criterial pollutant emissions

**Significant benefits** generated for near port communities in New Jersey by replacing older engines that power tugs, ferries and other marine workboats.
Resources for You

Find all this and more at
https://www.dieselforum.org/news-and-resources/

NEW JERSEY FACT SHEET

Did you know? 41% of heavy-duty vehicles in New Jersey meet or beat 2010 U.S. EPA emission standards for particulate matter and NOx. Learn more on the New Jersey Fact Sheet.¹

GET THE DETAILS

https://www.dieselforum.org/in-your-state
Thank You

More information may be found at https://www.dieselforum.org

Contact Us: dtf@dieselforum.org
Twitter: #cleandiesel
Facebook: https://www.facebook.com/dieseltechforum/